

UNITED STATES PATENT APPLICATION FOR:

**METHOD AND APPARATUS FOR CEMENTING DRILL STRINGS IN PLACE
FOR ONE PASS DRILLING AND COMPLETION OF OIL AND GAS WELLS**

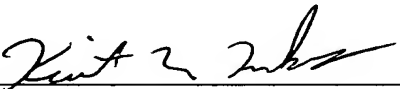
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METHOD AND APPARATUS FOR CEMENTING DRILL STRINGS IN PLACE FOR ONE PASS DRILLING AND COMPLETION OF OIL AND GAS WELLS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Portions of this application were disclosed in U.S. Disclosure Document No. 362582 filed on Sep. 30, 1994, which is incorporated herein by reference.

[0002] This application is a continuation of co-pending U.S. Patent Application Serial Number 10/162,302, filed on June 4, 2002, which is herein incorporated by reference in its entirety. U.S. Patent Application Serial Number 10/162,302 is a continuation-in-part of U.S. Patent Application Number 09/487,197 filed on January 19, 2000, now U.S. Patent Number 6,397,946, which is herein incorporated by reference in its entirety. U.S. Patent Number 6,397,946 is a continuation-in-part of U.S. Patent Application Number 09/295,808 filed on April 20, 1999, now U.S. Patent Number 6,263,987, which is herein incorporated by reference in its entirety. U.S. Patent Number 6,263,987 is a continuation-in-part of U.S. Patent Application Number 08/708,396 filed on September 3, 1996, now U.S. Patent Number 5,894,897, which is incorporated herein by reference in its entirety. U.S. Patent Number 5,894,897 is a continuation-in-part of U.S. Patent Application Number 08/323,152 filed on October 14, 1994, now U.S. Patent Number 5,551,521, which is herein incorporated by reference in its entirety.

[0003] This application further claims benefit of U.S. Provisional Patent Application Serial Number 60/313,654 filed on August 19, 2001, U.S. Provisional Patent Application Serial Number 60/353,457 filed on January 31, 2002, U.S. Provisional Patent Application Serial Number 60/367,638 filed on March 26, 2002, and U.S. Provisional Patent Application Serial Number 60/384,964 filed on June 3, 2002. All of the above United States Provisional Patent Applications are herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

Field of Invention

[0004] The field of invention relates to apparatus that uses the steel drill string attached to a drilling bit during drilling operations used to drill oil and gas wells for a second purpose as the casing that is cemented in place during typical oil and gas well completions. The field of invention further relates to methods of operation of said apparatus that provides for the efficient installation a cemented steel cased well during one single pass down into the earth of the steel drill string. The field of invention further relates to methods of operation of the apparatus that uses the typical mud passages already present in a typical drill bit, including any watercourses in a "regular bit", or mud jets in a "jet bit", that allow mud to circulate during typical drilling operations for the second independent, and the distinctly separate, purpose of passing cement into the annulus between the casing and the well while cementing the drill string into place during one single drilling pass into the earth. The field of invention further relates to apparatus and methods of operation that provides the pumping of cement down the drill string, through the mud passages in the drill bit, and into the annulus between the formation and the drill string for the purpose of cementing the drill string and the drill bit into place during one single drilling pass into the formation. The field of invention further relates to a one-way cement valve and related devices installed near the drill bit of the drill string that allows the cement to set up efficiently while the drill string and drill bit are cemented into place during one single drilling pass into the formation.

Description of the Prior Art

[0005] From an historical perspective, completing oil and gas wells using rotary drilling techniques has in recent times comprised the following typical steps. With a pile driver or rotary rig, install any necessary conductor pipe on the surface for attachment of the blowout preventer and for mechanical support at the wellhead. Install and cement into place any surface casing necessary to prevent washouts and cave-ins near the surface, and to prevent the contamination of freshwater sands as directed by state and federal regulations. Choose the dimensions of the drill bit to result in the desired sized production well. Begin rotary drilling of the production well with a first drill bit. Simultaneously circulate drilling mud into the well while drilling. Drilling mud is circulated downhole to carry rock chips to the surface, to prevent blowouts, to prevent excessive mud loss into formation, to cool the bit, and to clean

the bit. After the first bit wears out, pull the drill string out, change bits, lower the drill string into the well and continue drilling. It should be noted here that each "trip" of the drill bit typically requires many hours of rig time to accomplish the disassembly and reassembly of the drill string, pipe segment by pipe segment.

[0006] Drill the production well using a succession of rotary drill bits attached to the drill string until the hole is drilled to its final depth. After the final depth is reached, pull out the drill string and its attached drill bit. Assemble and lower the production casing into the well while back filling each section of casing with mud as it enters the well to overcome the buoyancy effects of the air filled casing (caused by the presence of the float collar valve), to help avoid sticking problems with the casing, and to prevent the possible collapse of the casing due to accumulated build-up of hydrostatic pressure.

[0007] To "cure the cement under ambient hydrostatic conditions", typically execute a two-plug cementing procedure involving a first Bottom Wiper Plug before and a second Top Wiper Plug behind the cement that also minimizes cement contamination problems comprised of the following individual steps. Introduce the Bottom Wiper Plug into the interior of the steel casing assembled in the well and pump down with cement that cleans the mud off the walls and separates the mud and cement. Introduce the Top Wiper Plug into the interior of the steel casing assembled into the well and pump down with water under pump pressure thereby forcing the cement through the float collar valve and any other one-way valves present. Allow the cement to cure.

SUMMARY OF THE INVENTION

[0008] Apparatus and methods of operation of that apparatus are disclosed that allow for cementation of a drill string with attached drill bit into place during one single drilling pass into a geological formation. The process of drilling the well and installing the casing becomes one single process that saves installation time and reduces costs during oil and gas well completion procedures. Apparatus and methods of operation of the apparatus are disclosed that use the typical mud passages already present in a typical rotary drill bit, including any watercourses in a "regular bit", or mud jets in a "jet bit", for the second independent purpose of passing

cement into the annulus between the casing and the well while cementing the drill string in place. This is a crucial step that allows a "Typical Drilling Process" involving some 14 steps to be compressed into the "New Drilling Process" that involves only 7 separate steps as described in the Description of the Preferred Embodiments below. The New Drilling Process is now possible because of "Several Recent Changes in the Industry" also described in the Description of the Preferred Embodiments below. In addition, the New Drilling Process also requires new apparatus to properly allow the cement to cure under ambient hydrostatic conditions. That new apparatus includes a Latching Subassembly, a Latching Float Collar Valve Assembly, the Bottom Wiper Plug, and the Top Wiper Plug. Suitable methods of operation are disclosed for the use of the new apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 shows a section view of a drill string in the process of being cemented in place during one drilling pass into formation with a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Apparatus and methods of operation of that apparatus are disclosed herein in the preferred embodiments of the invention that allow for cementation of a drill string with attached drill bit into place during one single drilling pass into a geological formation. The method of drilling the well and installing the casing becomes one single process that saves installation time and reduces costs during oil and gas well completion procedures as documented in the following description of the preferred embodiments of the invention. Apparatus and methods of operation of the apparatus are disclosed herein that use the typical mud passages already present in a typical rotary drill bit, including any watercourses in a "regular bit", or mud jets in a "jet bit", for the second independent purpose of passing cement into the annulus between the casing and the well while cementing the drill string in place.

[0011] FIG. 1 shows a section view of a drill string in the process of being cemented in place during one drilling pass into formation. A borehole 2 is drilled through the earth including geological formation 4. The borehole 2 is drilled with a

milled tooth rotary drill bit 6 having milled steel roller cones 8, 10, and 12 (not shown for simplicity). A standard water passage 14 is shown through the rotary cone drill bit. This rotary bit could equally be a tungsten carbide insert roller cone bit having jets for water passages, the principle of operation and the related apparatus being the same for either case for the preferred embodiment herein.

[0012] The threads 16 on rotary drill bit 6 are screwed into the Latching Subassembly 18. The Latching Subassembly 18 is also called the Latching Sub for simplicity herein. The Latching Sub 18 is a relatively thick-walled steel pipe having some functions similar to a standard drill collar.

[0013] The Latching Float Collar Valve Assembly 20 is pumped downhole with drilling mud after the depth of the well is reached. The Latching Float Collar Valve Assembly 20 is pumped downhole with mud pressure pushing against the Upper Seal 22 of the Latching Float Collar Valve Assembly 20. The Latching Float Collar Valve Assembly 20 latches into place into Latch Recession 24. The Latch 26 of the Latching Float Collar Valve Assembly 20 is shown latched into place with Latching Spring 28 pushing against Latching Mandrel 30.

[0014] The Float 32 of the Latching Float Collar Valve Assembly 20 seats against the Float Seating Surface 34 under the force from Float Collar Spring 36 that makes a one-way cement valve. However, the pressure applied to the mud or cement from the surface may force open the Float to allow mud or cement to be forced into the annulus generally designated as 38 in FIG. 1. This one-way cement valve is a particular example of "a one-way cement valve means installed near the drill bit" which is a term defined herein. The one-way cement valve means may be installed at any distance from the drill bit but is preferentially installed "near" the drill bit.

[0015] FIG. 1 corresponds to the situation where cement is in the process of being forced from the surface through the Latching Float Collar Valve Assembly 20. In fact, the top level of cement in the well is designated as element 40. Below 40, cement fills the annulus of the borehole 2. Above 40, mud fills the annulus of the borehole 2. For example, cement is present at position 42 and drilling mud is present at position 44 in FIG. 1.

[0016] Relatively thin-wall casing, or drill pipe, designated as element 46 in FIG. 1, is attached to the Latching Sub 18. The bottom male threads of the drill pipe 48 are screwed into the female threads 50 of the Latching Sub 18.

[0017] The drilling mud was wiped off the walls of the drill pipe 48 in the well with Bottom Wiper Plug 52. The Bottom Wiper Plug 52 is fabricated from rubber in the shape shown. Portions 54 and 56 of the Upper Seal of the Bottom Wiper Plug 52 are shown in a ruptured condition in FIG. 1. Initially, they sealed the upper portion of the Bottom Wiper Plug 52. Under pressure from cement, the Bottom Wiper Plug 52 is pumped down into the well until the Lower Lobe 58 of the Bottom Wiper Plug 52 latches into place into Latching Sub Recession 60 in the Latching Sub 18. After the Bottom Wiper Plug 52 latches into place, the pressure of the cement ruptures the Upper Seal of the Bottom Wiper Plug 52. A Bottom Wiper Plug Lobe 62 is shown in FIG. 1. Such lobes provide an efficient means to wipe the mud off the walls of the drill pipe 48 while the Bottom Wiper Plug 52 is pumped downhole with cement.

[0018] Top Wiper Plug 64 is being pumped downhole by water 66 under pressure in the drill pipe. As the Top Wiper Plug 64 is pumped down under water pressure, the cement remaining in region 68 is forced downward through the Bottom Wiper Plug 52, through the Latching Float Collar Valve Assembly 20, through the waterpassages of the drill bit and into the annulus in the well. A Top Wiper Plug Lobe 70 is shown in FIG. 1. Such lobes provide an efficient means to wipe the cement off the walls of the drill pipe while the Top Wiper Plug 64 is pumped downhole with water.

[0019] After the Bottom Surface 72 of the Top Wiper Plug 64 is forced into the Top Surface 74 of the Bottom Wiper Plug 52, almost the entire "cement charge" has been forced into the annulus between the drill pipe and the hole. As pressure is reduced on the water, the Float of the Latching Float Latching Float Collar Valve Assembly 20 seals against the Float Seating Surface. As the water pressure is reduced on the inside of the drill pipe, then the cement in the annulus between the drill pipe and the hole can cure under ambient hydrostatic conditions. This procedure herein provides an example of the proper operation of a "one-way cement valve means".

[0020] Therefore, the preferred embodiment in FIG. 1 provides apparatus that uses the steel drill string attached to a drilling bit during drilling operations used to drill oil and gas wells for a second purpose as the casing that is cemented in place during typical oil and gas well completions.

[0021] The preferred embodiment in FIG. 1 provides apparatus and methods of operation of said apparatus that results in the efficient installation of a cemented steel cased well during one single pass down into the earth of the steel drill string thereby making a steel cased borehole or cased well.

[0022] The steps described herein in relation to the preferred embodiment in FIG. 1 provides a method of operation that uses the typical mud passages already present in a typical rotary drill bit, including any watercourses in a "regular bit", or mud jets in a "jet bit", that allow mud to circulate during typical drilling operations for the second independent, and the distinctly separate, purpose of passing cement into the annulus between the casing and the well while cementing the drill string into place during one single pass into the earth.

[0023] The preferred embodiment of the invention further provides apparatus and methods of operation that result in the pumping of cement down the drill string, through the mud passages in the drill bit, and into the annulus between the formation and the drill string for the purpose of cementing the drill string and the drill bit into place during one single drilling pass into the formation.

[0024] The apparatus described in the preferred embodiment in FIG. 1 also provide a one-way cement valve and related devices installed near the drill bit of the drill string that allows the cement to set up efficiently while the drill string and drill bit are cemented into place during one single drilling pass into the formation.

[0025] Methods of operation of apparatus disclosed in FIG. 1 have been disclosed that use the typical mud passages already present in a typical rotary drill bit, including any watercourses in a "regular bit", or mud jets in a "jet bit", for the second independent purpose of passing cement into the annulus between the casing and the well while cementing the drill string in place. This is a crucial step that allows a "Typical Drilling Process" involving some 14 steps to be compressed

into the "New Drilling Process" that involves only 7 separate steps as described in detail below. The New Drilling Process is now possible because of "Several Recent Changes in the Industry" also described in detail below.

[0026] Typical procedures used in the oil and gas industries to drill and complete wells are well documented. For example, such procedures are documented in the entire "Rotary Drilling Series" published by the Petroleum Extension Service of the University of Texas at Austin, Austin, Tex. that is included herein by reference in its entirety comprised of the following: Unit I--"The Rig and Its Maintenance" (12 Lessons); Unit II--"Normal Drilling Operations" (5 Lessons); Unit III--Nonroutine Rig Operations (4 Lessons); Unit IV--Man Management and Rig Management (1 Lesson); and Unit V--Offshore Technology (9 Lessons). All of the individual Glossaries of all of the above Lessons are explicitly included in the specification herein and any and all definitions in those Glossaries shall be considered explicitly referenced herein.

[0027] Additional procedures used in the oil and gas industries to drill and complete wells are well documented in the series entitled "Lessons in Well Servicing and Workover" published by the Petroleum Extension Service of the University of Texas at Austin, Austin, Tex. that is included herein by reference in its entirety comprised of all 12 Lessons. All of the individual Glossaries of all of the above Lessons are explicitly included in the specification herein and any and all definitions in those Glossaries shall be considered explicitly referenced herein.

[0028] With reference to typical practices in the oil and gas industries, a typical drilling process may therefore be described in the following.

Typical Drilling Process

[0029] From an historical perspective, completing oil and gas wells using rotary drilling techniques has in recent times comprised the following typical steps:

Step 1

[0030] With a pile driver or rotary rig, install any necessary conductor pipe on the surface for attachment of the blowout preventer and for mechanical support at the wellhead.

Step 2

[0031] Install and cement into place any surface casing necessary to prevent washouts and cave-ins near the surface, and to prevent the contamination of freshwater sands as directed by state and federal regulations.

Step 3

[0032] Choose the dimensions of the drill bit to result in the desired sized production well. Begin rotary drilling of the production well with a first drill bit. Simultaneously circulate drilling mud into the well while drilling. Drilling mud is circulated downhole to carry rock chips to the surface, to prevent blowouts, to prevent excessive mud loss into formation, to cool the bit, and to clean the bit. After the first bit wears out, pull the drill string out, change bits, lower the drill string into the well and continue drilling. It should be noted here that each "trip" of the drill bit typically requires many hours of rig time to accomplish the disassembly and reassembly of the drill string, pipe segment by pipe segment.

Step 4

[0033] Drill the production well using a succession of rotary drill bits attached to the drill string until the hole is drilled to its final depth.

Step 5

[0034] After the final depth is reached, pull out the drill string and its attached drill bit.

Step 6

[0035] Perform open-hole logging of the geological formations to determine the amount of oil and gas present. This typically involves measurements of the porosity of the rock, the electrical resistivity of the water present, the electrical resistivity of

the rock, certain neutron measurements from within the open-hole, and the use of Archie's Equations. If no oil and gas is present from the analysis of such open-hole logs, an option can be chosen to cement the well shut. If commercial amounts of oil and gas are present, continue the following steps.

Step 7

[0036] Typically reassemble drill bit and drill string into the well to clean the well after open-hole logging.

Step 8

[0037] Pull out the drill string and its attached drill bit.

Step 9

[0038] Attach the casing shoe into the bottom male pipe threads of the first length of casing to be installed into the well. This casing shoe may or may not have a one-way valve ("casing shoe valve") installed in its interior to prevent fluids from back-flowing from the well into the casing string.

Step 10

[0039] Typically install the float collar onto the top female threads of the first length of casing to be installed into the well which has a one-way valve ("float collar valve") that allows the mud and cement to pass only one way down into the hole thereby preventing any fluids from back-flowing from the well into the casing string. Therefore, a typical installation has a casing shoe attached to the bottom and the float collar valve attached to the top portion of the first length of casing to be lowered into the well. Please refer to pages 28-31 of the book entitled "Casing and Cementing" Unit II Lesson 4, Second Edition, of the Rotary Drilling Series, Petroleum Extension Service, The University of Texas at Austin, Tex., 1982 (hereinafter defined as "Ref.1"). All of the individual definitions of words and phrases in the Glossary of Ref. 1 are explicitly included herein in their entirety.

Step 11

[0040] Assemble and lower the production casing into the well while back filling each section of casing with mud as it enters the well to overcome the buoyancy effects of the air filled casing (caused by the presence of the float collar valve), to help avoid sticking problems with the casing, and to prevent the possible collapse of the casing due to accumulated build-up of hydrostatic pressure.

Step 12

[0041] To "cure the cement under ambient hydrostatic conditions", typically execute a two-plug cementing procedure involving a first Bottom Wiper Plug before and a second Top Wiper Plug behind the cement that also minimizes cement contamination problems comprised of the following individual steps:

A. Introduce the Bottom Wiper Plug into the interior of the steel casing assembled in the well and pump down with cement that cleans the mud off the walls and separates the mud and cement (Ref. 1, pages 28-31).

B. Introduce the Top Wiper Plug into the interior of the steel casing assembled into the well and pump down with water under pump pressure thereby forcing the cement through the float collar valve and any other one-way valves present (Ref. 1, pages 28-31).

C. After the Bottom Wiper Plug and the Top Wiper Plug have seated in the float collar, release the pump pressure on the water column in the casing that results in the closing of the float collar valve which in turn prevents cement from backing up into the interior of the casing. The resulting interior pressure release on the inside of the casing upon closure of the float collar valve prevents distortions of the casing that might prevent a good cement seal (Ref. 1, page 30). In such circumstances, "the cement is cured under ambient hydrostatic conditions".

Step 13

[0042] Allow the cement to cure.

Step 14

[0043] Follow normal "final completion operations" that include installing the tubing with packers and perforating the casing near the producing zones. For a description of such normal final completion operations, please refer to the book entitled "Well Completion Methods", Well Servicing and Workover, Lesson 4, from the series entitled "Lessons in Well Servicing and Workover", Petroleum Extension Service, The University of Texas at Austin, Tex., 1971 (hereinafter defined as "Ref. 2"). All of the individual definitions of words and phrases in the Glossary of Ref. 2 are explicitly included herein in their entirety. Other methods of completing the well are described therein that shall, for the purposes of this application herein, also be called "final completion operations".

Several Recent Changes in the Industry

[0044] Several recent concurrent changes in the industry have made it possible to reduce the number of steps defined above. These changes include the following:

a. Until recently, drill bits typically wore out during drilling operations before the desired depth was reached by the production well. However, certain drill bits have recently been able to drill a hole without having to be changed. For example, please refer to the book entitled "The Bit", Unit I, Lesson 2, Third Edition, of the Rotary Drilling Series, The University of Texas at Austin, Tex., 1981 (hereinafter defined as "Ref. 3"). All of the individual definitions of words and phrases in the Glossary of Ref. 3 are explicitly included herein in their entirety. On page 1 of Ref. 3 it states: "For example, often only one bit is needed to make a hole in which the casing will be set." On page 12 of Ref. 3 it states in relation to tungsten carbide insert roller cone bits: "Bit runs as long as 300 hours have been achieved; in some instances, only one or two bits have been needed to drill a well to total depth." This is particularly so since the advent of the sealed bearing tri-cone bit designs appeared in 1959 (Ref. 3, page 7) having tungsten carbide inserts (Ref. 3, page 12). Therefore, it is now practical to talk about drill bits lasting long enough for drilling a well during one pass into the formation, or "one pass drilling".

b. Until recently, it has been impossible or impractical to obtain sufficient geophysical information to determine the presence or absence of oil and gas from inside steel pipes in wells. Heretofore, either standard open-hole logging tools or Measurement-While-Drilling ("MWD") tools were used in the open-hole to obtain such information. Therefore, the industry has historically used various open-hole tools to measure formation characteristics. However, it has recently become possible to measure the various geophysical quantities listed in Step 6 above from inside steel pipes such as drill strings and casing strings. For example, please refer to the book entitled "Cased Hole Log Interpretation Principles/Applications", Schlumberger Educational Services, Houston, Tex., 1989. Please also refer to the article entitled "Electrical Logging: State-of-the-Art", by Robert E. Maute, The Log Analyst, May-June 1992, pages 206-227.

[0045] Because drill bits typically wore out during drilling operations until recently, different types of metal pipes have historically evolved which are attached to drilling bits, which, when assembled, are called "drill strings". Those drill strings are different than typical "casing strings" run into the well. Because it was historically absolutely necessary to do open-hole logging to determine the presence or absence of oil and gas, the fact that different types of pipes were used in "drill strings" and "casing strings" was of little consequence to the economics of completing wells. However, it is possible to choose the "drill string" to be acceptable for a second use, namely as the "casing string" that is to be installed after drilling has been completed.

New Drilling Process

[0046] Therefore, the preferred embodiments of the invention herein reduce and simplify the above 14 steps as follows:

Repeat Steps 1-2 above.

Steps 3-5 (Revised)

[0047] Choose the drill bit so that the entire production well can be drilled to its final depth using only one single drill bit. Choose the dimensions of the drill bit for

desired size of the production well. If the cement is to be cured under ambient hydrostatic conditions, attach the drill bit to the bottom female threads of the Latching Subassembly ("Latching Sub"). Choose the material of the drill string from pipe material that can also be used as the casing string. Attach the first section of drill pipe to the top female threads of the Latching Sub. Rotary drill the production well to its final depth during "one pass drilling" into the well. While drilling, simultaneously circulate drilling mud to carry the rock chips to the surface, to prevent blowouts, to prevent excessive mud loss into formation, to cool the bit, and to clean the bit.

Step 6 (Revised)

[0048] After the final depth of the production well is reached, perform logging of the geological formations to determine the amount of oil and gas present from inside the drill pipe of the drill string. This typically involves measurements from inside the drill string of the necessary geophysical quantities as summarized in Item "b." of "Several Recent Changes in the Industry". If such logs obtained from inside the drill string show that no oil or gas is present, then the drill string can be pulled out of the well and the well filled in with cement. If commercial amounts of oil and gas are present, continue the following steps.

Steps 7-11 (Revised)

[0049] If the cement is to be cured under ambient hydrostatic conditions, pump down a Latching Float Collar Valve Assembly with mud until it latches into place in the notches provided in the Latching Sub located above the drill bit.

Steps 12-13 (Revised)

[0050] To "cure the cement under ambient hydrostatic conditions", typically execute a two-plug cementing procedure involving a first Bottom Wiper Plug before and a second Top Wiper Plug behind the cement that also minimizes cement contamination comprised of the following individual steps:

A. Introduce the Bottom Wiper Plug into the interior of the drill string assembled in the well and pump down with cement that cleans the mud off the walls and separates the mud and cement.

B. Introduce the Top Wiper Plug into the interior of the drill string assembled into the well and pump down with water thereby forcing the cement through any Float Collar Valve Assembly present and through the watercourses in "a regular bit" or through the mud nozzles of a "jet bit" or through any other mud passages in, the drill bit into the annulus between the drill string and the formation.

C. After the Bottom Wiper Plug and Top Wiper Plug have seated in the Latching Float Collar Valve Assembly, release the pressure on the interior of the drill string that results in the closing of the float collar which in turn prevents cement from backing up in the drill string. The resulting pressure release upon closure of the float collar prevents distortions of the drill string that might prevent a good cement seal as described earlier. I.e., "the cement is cured under ambient hydrostatic conditions".

Repeat Step 14 above.

[0051] Therefore, the "New Drilling Process" has only 7 distinct steps instead of the 14 steps in the "Typical Drilling Process". The "New Drilling Process", consequently has fewer steps, is easier to implement, and will be less expensive.

[0052] The preferred embodiment of the invention disclosed in FIG. 1 requires a Latching Subassembly and a Latching Float Collar Valve Assembly. The advantage of this approach is that the Float 32 of the Latching Float Collar Valve Assembly and the Float Seating Surface 34 in FIG. 1 are installed at the end of the drilling process and will not be worn due to mud passage during normal drilling operations.

[0053] Another preferred embodiment of the invention provides a float and float collar valve assembly permanently installed within the Latching Subassembly at the beginning of the drilling operations. However, such a preferred embodiment has the disadvantage that drilling mud passing by the float and the float collar valve

assembly during normal drilling operations will tend to wear on the mutually sealing surfaces.

[0054] The drill bit described in FIG. 1 is a milled steel toothed roller cone bit. However, any rotary bit can be used with the invention. A tungsten carbide insert roller cone bit can be used. Any type of diamond bit or drag bit can be used. The invention may be used with any drill bit described in Ref. 3 above that possesses mud passages, waterpassages, or passages for gas. Any type of rotary drill bit can be used possessing such passageways. Similarly, any type of bit whatsoever that utilizes any fluid or gas that passes through passageways in the bit can be used whether or not the bit rotates.

[0055] While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, but rather as exemplification of preferred embodiments thereto. As have been briefly described, there are many possible variations. Accordingly, the scope of the invention should be determined not only by the embodiments illustrated, but by the appended claims and their legal equivalents.